THE TALE OF THE MCDONALD MINE: *WHAT TO DO WHEN THE CATEGORY 5 KATRINA OF ACID MINE DRAINAGE REMEDIATION STRIKES?*[1]

Constance Anne Lyons[2]

Abstract. In late summer of 2005, fate struck a blow to acid mine drainage (AMD) remediation that felt like a Category 5 Hurricane Katrina on New Orleans. Within a matter of days, the once highly praised recovery of four miles of Georges Creek was lost and the North Branch of the Potomac, a premier fishing destination, was threatened. The Culprit was the McDonald Mine, a pre-law abandoned underground coal mine. The Maryland Bureau of Mines installed a lime doser in the late 1990's to treat the acid discharge from the mine. From 2002 until August 22, 2005, the water quality was so improved in lower Georges Creek that the stream was home to native and stocked fish and a source of hope and recovery to the Appalachian communities that live along its banks. By August 24, 2005, a major fish kill was reported in Georges Creek. Water quality samples indicated a drastic change in the character of the mine discharge, decimating the lower reaches of Georges Creek. Seep flows had tripled and seep water quality analyses reported ten-fold increases in the acidity (16,000 mg/l) and high concentrations of iron (>4000 mg/l) and aluminum (581 mg/l). To date, the mine continues to discharge extremely degraded water. This paper will describe the environmental impacts, the struggle to contain the damage, the possible causes, the quest for potential solutions, the future of long term treatment, the overwhelming limitations of technical and financial solutions, the turmoil and loss of trust of the public, and the critical need for citizens and agencies involved in environmental clean-up and protection to work together.

Additional Key Words: proceedings, Georges Creek, McDonald Mine

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[2]Constance Anne Lyons is a Natural Resources Planner, Maryland Department of the Environment, Frostburg, MD 21532

Introduction

The Maryland Department of the Environment, Bureau of Mines (Bureau) regulates the mining of coal in Maryland. Coal is only found in two most western counties. About 5.5 million tons of coal is mined annually. In 1977, Congress passed the Surface Mining Control & Reclamation Act to regulate coal mining throughout the country. MD Abandoned Mine Land Program restores pre-law land and water impacted by coal mining. Since 1982, the AML Program has reclaimed 2000 of the 9500 pre-law abandoned surface mine acres. In 1979, the Maryland Abandoned Mine Study reported pre-law abandoned mine drainage sites had impaired over 450 miles of impaired stream. By 2005, over 80 miles of Stream were improved with Passive and Active Treatment Technologies through the efforts of the State and other committed Stakeholders. Streams were becoming fishable and destination spots for Anglers and Recreationists. Success was sweet! Everyone was happy…

Welcome to Georges Creek: The Land of AMD Treatment

Background

The Georges Creek Watershed, located in the rugged Allegheny Mountains coal mining region of Western Maryland, is rich in history, cultural heritage and natural resources. Many of the watershed's communities, however, continue to be plagued by challenging water resource problems such as economic loss and personal hardship from persistent, sometimes catastrophic flooding, poor water quality and dewatering of stream channels. Georges Creek drains portions of the Maryland bituminous coalfield. The Georges Creek watershed is considered to be one of Maryland's most heavily mined watersheds, left with a legacy of thousands of acres disturbed by pre-law mining practices leaving miles of stream impaired by acid mine drainages (AMD).

The Bureau, in close cooperation with the local citizens through the Georges Creek Watershed Association (GCWA) and local Allegany County government agencies, selected Georges Creek as a high priority watershed for restoration efforts to remove existing environmental problems caused by pre-law mining and recent catastrophic flooding. The GCWA is a group of citizens who have a good working relationship with local agencies. Their commitment grew out of their love for the region and their vision of a river clean and free flowing, providing a source of exciting opportunities for recreation, fishing, and economic development.

"We envision a reduction, and where possible, the elimination from impact of Acid Mine Drainage and Combined Sewage Overflows." We envision healthy streams and tributaries that support a diversity of fish and other aquatic organisms; a community that aids in the development of activities and projects that result in the reduction of flooding impacts. We envision a trail and greenway system starting in Frostburg, MD and ending at the Potomac River in Westernport. We envision numerous

public access points where fisherman, school children, and families will be able to enjoy and appreciate the stream. We envision a healthy community where citizens, public officials, scientists, and planners work side-by-side to identify and address issues related to resource protection and quality of life."
-GCWA Vision Statement-

This vision had empowered and energized this small Appalachian community that in the past accepted as normal the reddish streams devoid of fish that flowed through their towns and backyards. With commitment to this vision, local government completed stream stabilization and flood mitigation projects in the mainstem and some tributaries of Georges Creek. The Bureau's Abandoned Mine Land Section completed several stream channel lining and land reclamation projects in the watershed. By 2005, the Bureau had completed six acid mine drainage (AMD) water treatment projects in the watershed with four more systems in the planning stage. These projects were funded through grant programs of the Office of Surface Mining and the U.S. Environmental Protection Agency Region 3. Today, in spite of the drastic and unanticipated severe impact of McDonald Mine since August 2005, this community strives to see a healthy, thriving Georges Creek become a reality, a place to live, play, and grow, no longer marred by the legacies of the past. Time, patience, and commitment are needed by all stakeholders to keep the vision alive.

The Adversary: McDonald Mine Discharge

The McDonald Mine is a pre-law abandoned underground coal mine in the town of Barton, Maryland. Records indicate the mine was operated during the 1930's and 40's and flows directly into the mainstem of Georges Creek. The mine discharges the worst acid mine drainage in Maryland. The flow rate of the mine has varied from a low of 2 gallons a minute to over 60 gallons a minute, carrying between 2,000 and 16,000 milligrams per liter of acidity. The pH of the discharge is in the low 2's. Stream pH for living resources is best between 6.5 and 8.5. The McDonald Mine discharge was, and remains, the most significant pollutant in the lower portion of Georges Creek (Table 1).

Table 1. McDonald Seep Data Prior to August 2005

Flow	30 - 64 gpm
pH	1.5 - 3.3
Iron	290 - 727 mg/l
Aluminum	66 - 506 mg/l
Acidity	1600 - 2500 mg/l
Sulfates	2300 - 6500 mg/l
T. Dis Solids	3507 - 6545 mg/l

Enter The Hero? Or the Fool? MDE Installs Mine Drainage Controls

The Maryland Department of the Environment, Bureau of Mines targeted the McDonald Mine for mine drainage treatment in the late 1990's (Table 2). A lime-dosing machine to treat the discharge was installed in October 2002 at a cost of $132,000. Annual operating costs average $20,000 (Figure 1). From 2002 until August 22, 2005, the water quality was improved in the lower Georges Creek mainstem allowing for the recolonization of the stream with native and stocked fish and other living resources (Figure 2). Since installation,

Figure 1. The McDonald Mine Doser

Figure 2. Georges Creek Below Doser Prior to August 2005

the doser treated the mine discharge by neutralizing the acidity, allowing for the recovery of Georges Creek to its confluence with the North Branch of the Potomac River until August 2005 (Figure 3).

Table 2. Pre-August 2005 (04/06/2006) Georges Creek Water Quality 200 yds Downstream of Doser

pH	7.1
Iron	0.8 mg/l
Aluminum	0.25 mg/l
Acidity	0.0 mg/l
Alkalinity	50 mg/l
Sulfates	106.2 mg/l
T. Dis. Solids	374 mg/l

Figure 1. Georges Creek below McDonald Doser April 2005

McDonald Mine Problem Escalates: Water Quality Deteriorates on Georges Creek

On August 22, 2005, Maryland Department of the Environment, Bureau of Mines personnel observed a plume of orange water throughout the lower half of Georges Creek. Bureau staff investigated the source of the problem and determined that the problem originated at the McDonald Mine seep. Water samples were collected of the seep and selected locations along Georges Creek above and below the origin of the problem on August 23, 2005 (Tables 3,4, & 5). On August 24, 2005, a major fish kill was reported in the recovered sections of Georges Creek below the mine. Water quality samples indicate a drastic change in the character of the acid mine drainage, causing major impact on the water downstream in Georges Creek. Analysis of the water quality samples by the Maryland Department of the Environment, Bureau of Mines Laboratory indicated ten-fold increases in the acidity of the seep that exceeded the capacity of the doser's treatment capability to neutralize the acid in Georges Creek last summer. Also, the concentrations of iron and aluminum in the seep also increased significantly leading to precipitation of metals in the mainstem of Georges Creek. Since the event, the doser has been able to neutralize the seep discharges so as to reduce the impact on the mainstem of the North Branch of the Potomac River. Water samples indicate some minimum impact on the North Branch but much less than would occur without the ongoing and continued operation of the McDonald Mine doser.

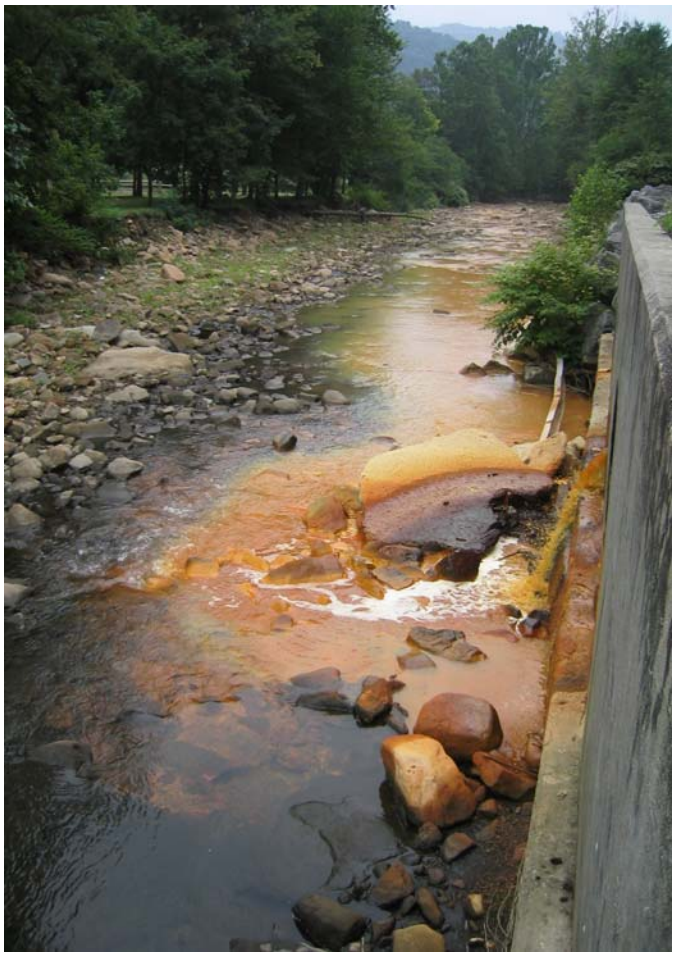

Figure 2. McDonald Mine Discharge August 23, 2005

Table 3. McDonald Mine Seep
Water Quality on **08/23/05**

Flow	60 gpm
pH	2.6
Iron	4000 mg/l
Aluminum	582 mg/l
Acidity	16000 mg/l
Sulfates	20687 mg/l
T. Dis Solids	31055 mg/l

Table 4. Water Quality 200 yds Downstream of McDonald Mine Seep and Doser on **08/23/05**

pH	3.2
Iron	203.6 mg/l
Aluminum	20.2 mg/l
Acidity	502 mg/l
Alkalinity	0.0 mg/l
Sulfates	1473.6 mg/l
T. Dis Solids	2126 mg/l

Table 5. Water Quality at the Confluence of Georges Creek and the North Branch of the Potomac River- 4 miles downstream of McDonald Mine Seep and Doser on **08/23/05**

pH	5.0
Iron	26.6 mg/l
Aluminum	5.59 mg/l
Acidity	87.5 mg/l
Alkalinity	5.4 mg/l
Sulfates	1255 mg/l
T. Dis Solids	1726 mg/l

The Search Begins for Causes and Solutions

Why Category 5 Hurricane Katrina Comparison?

It happened in less than a week's time. It happened when Maryland's governor was visiting western Maryland for an environmental media event. It happened when the Maryland Department of the Environment Secretary talked about

Figure 4. Georges Creek immediately below McDonald Mine Seep August 31, 2005

the success of the acid mine drainage program in western Maryland. It happened during the worst drought seen in decades in Georges Creek. It killed four miles of stream in less than a week. It happened when we least expected. The definite cause remains a mystery, with no conclusive evidence of the direct or indirect cause for the drastic and abrupt change.

Figure 5. Georges Creek (on left) enters North Branch Potomac River October 2005

MDE Meets with Experts

As part of the investigation of the problem, experts from the U.S. Environmental Protection Agency, Hazardous Site Clean-Up Division, Maryland Emergency Response Team, and the National Mine Land Reclamation Center met with the Maryland Bureau of Mines staff on October 18 and October 21, 2005 to look at the McDonald Mine Seep and its impact on Georges Creek and the North Branch Potomac River. EPA Region III encouraged the Bureau to apply for a nationally competitive Brownfields grant, under the mine-scarred provision of the program, which would be used to assess possible treatment alternatives. Completion of the assessment phase would have lead to additional grant funds for brownfield clean up actions. A grant application for $200,000 was submitted in mid December; results were announced in late May 2006, and the McDonald Mine Project was not selected for brownfields funding.

GAI, a firm with expertise in mining, was brought on to review and report on the situation and provide guidance in approaching possible solutions. Report was finalized in early March 2006. No conclusive cause for the change in mine quality and quantity was determined. The report suggests that the most likely cause of the event was a roof-fall in the mine that has intercepted an upper aquifer and the inflowing water in the mine is in contact with new, unleached loose mine materials.

MDE Actions to Date

The McDonald Mine doser was fortunately installed and operating before, during, and after the August 22, 2005 McDonald Mine Seep breakout. The Bureau immediately sent staff out to collect water samples and data from August 23 show the devastating change in water quality. The Bureau has continued to investigate the situation, regularly collecting water quality samples of the seep and Georges Creek to determine if water quality will return to pre-August 22, 2005 conditions. For example, analyses of seep samples taken on April 6, 2005 (several months before the outbreak) reported concentrations of 163 mg/l for iron, 87 mg/l for aluminum, and acidities of 1,200 mg/l. There is an indication that some previously wet areas in the vicinity above the mine have become drier. The Bureau is investigating these areas to determine if there is correlation or link to the August 2005 event.

The Seep Characteristics Since August 2005.

The data shows that water quality of the seep has been improving since the August 22, 2005 event. Rainfall returned to normal last fall, providing much better in-stream dilution, allowing for notable improvement in water quality below the confluence of Georges Creek and the treated seep discharge through the winter months. Also, the seep is becoming less degraded over time as evidenced by the results of the weekly monitoring of the seep quality discharging from the mine. Current results for seep quality almost a year later, based on analysis of samples

collected on July 10, 2006, reported concentrations of 568 mg/l for iron, 96.3 mg/l for aluminum, and acidities of 2000 mg/l.

Although, concentrations have decreased consistently from the devastating highs of August 2005, the quality of the McDonald Mine seep remains extremely acidic and heavily metal laden and has not yet returned to pre-August quality. Water quality downstream of the seep still shows signs of increased pollution degradation. Water samples collected at the confluence of Georges Creek and the North Branch of the Potomac on July 10, 2006, reported concentrations of 9.69 mg/l for iron, 3.2 mg/l for aluminum, 46 mg/l for alkalinity and no acidity. Base seep flows have increased significantly over pre-August levels and increase even more in response to rainfall events. The Bureau of Mines continues to monitor the situation and collect bi-weekly water quality samples. As summer approaches with higher air temperatures and less rainfall, Georges Creek could be vulnerable again to the miles of unsightly and water quality impacts from the discharge of this seep with little dilution from upstream. The Bureau continues to add neutralizing lime to the offset the toxic nature of the impacts within the limits of the situation and natural events.

MDE Looks at Alternative Treatment Systems and Potential Costs

A potential action to immediately address the increased AMD loading is to install an AquaFix mechanism in the McDonald doser in place of the current bucket mechanism. This is the minimum change under investigation to provide improved treatment capability at the site. The cost estimate was $40,000 to upgrade the dosing mechanism using his technology. No action has been taken on updating the mechanism until other potential technologies are investigated with initial capital costs and annual operation and maintenance costs are developed for review. Immediate actions taken at the doser include installation of a stainless steel bucket, changes in the trough under the doser, and some other minor modifications to improve overall performance and maintenance requirements until more permanent action is determined.

Although the operation of the McDonald Doser reduces the impact of the McDonald Mine seep, it does not address the high concentrations of precipitating metals currently entering Georges Creek. Due to the higher seep flows and seep constituent concentrations, the metal loadings flowing into Georges Creek are much higher than anticipated when the doser was initially constructed. These factors are causing much greater impact on Georges Creek, chemically, biologically, and aesthetically. An expert in AMD treatment, Jonathan M. Dietz of Dietz-Gourley Consulting, LLC, visited the site and is reviewing the data and information collected since August 2005. Dietz proposes several alternative treatment technologies to replace or work in conjunction with the doser that, if installed, would collect and dewater the metal precipitates that are produced by the neutralization of the McDonald Mine Doser. The doser has effectively mitigated what would have been a chemical and biological disaster downstream on the North Branch of the Potomac River. The proposed alternative technologies are expected to have high capital construction costs and high operation and maintenance costs that exceed the current financial capabilities of the Bureau. However, without the

addition of a technology that collects the vast amount of metal laden precipitate flowing from the McDonald site, Georges Creek will continue to exhibit the effects of increased sedimentation and metal toxicity in the stretches below the doser effluent during low flows. The evaluation of potential treatment alternatives to the doser that might better address the seep precipitate problem along with an estimation of costs for capital construction and annual operation and maintenance are being conducted by Dietz at the time of this writing. Dietz is evaluating the McDonald site conditions, water chemistry and flow data collected to date. In late summer of 2006, Dietz will conduct treatment bench-scale testing on potential neutralization and remediation technologies: 1) Pulverized Limestone (PLAR), 2) Activated Iron Solids (AIS) and Pulverized Limestone, and 3) Hydrated Limestone. A final report is due in September 2006 and these recommendations will be presented at the 26th Annual National Association of Abandoned Mine Land Program Conference in Billings, Montana. Schematic representation of the potential technologies under consideration and preliminary capital and operation cost estimates for three potential abatement technologies are depicted in Figures 6-8 and Tables 6 and 7.

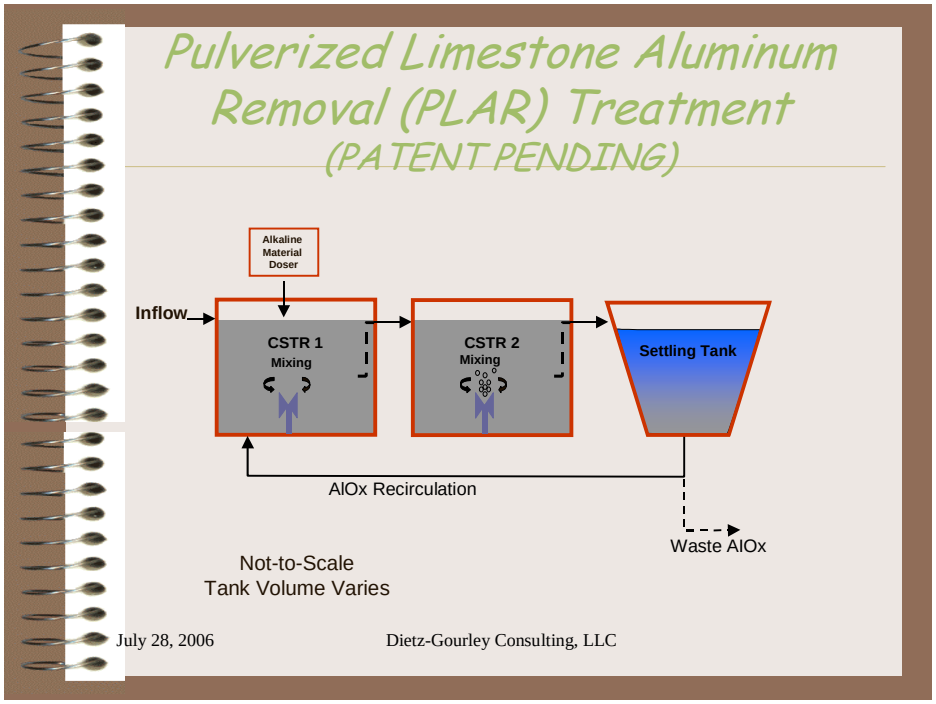

Figure 6. Schematic of one of three potential treatment technologies - PLAR

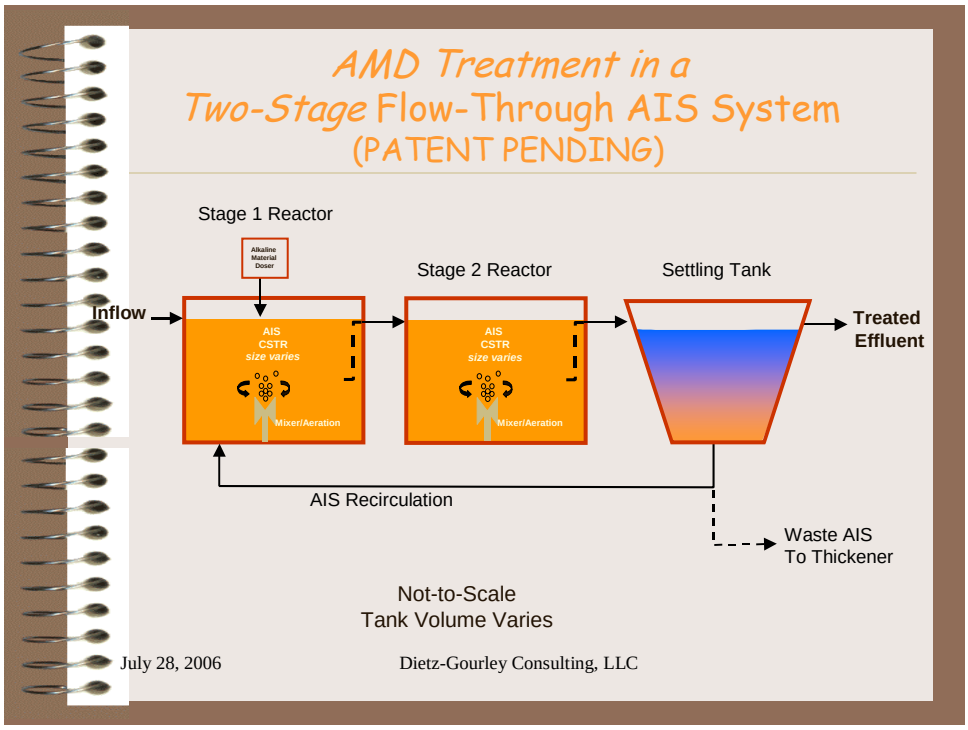

Figure 7. Schematic of one of three potential treatment technologies – Two Stage Flow-Through Activated Iron Sludge System (Patent Pending).

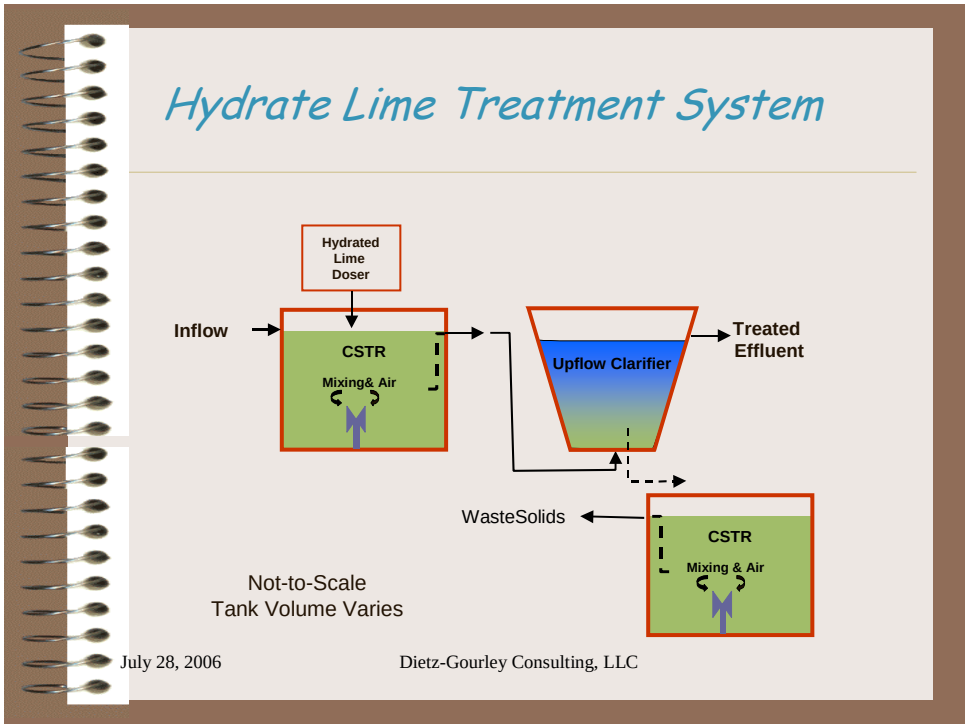

Figure 8. Schematic of one of three potential treatment technologies – Hydrated Lime Treatment System

McDonald: Cost Comparison

Flow = 250 gpm

Desc.	Package System $	Silo $	Site Work $	Total $
PLAR	130,000	~125,000	~25,000	~475,000
AIS 2-Stage	195,000			
Option 1				
PLAR	130,000	~125,000	~25,000	~280,000
Option 2				
Hydrated lime	250,000	~125,000	~25,000	~400,000

July 28, 2006 Dietz-Gourley Consulting, LLC

Table 6. Comparison of Capital Costs for Potential Treatment Systems

McDonald: O&M Comparison

Ave Flow = 200 gpm

Desc.	Chemical		Electricity	Solids	Labor
	lb/yr	$/yr	$/yr	CY/yr	
PLAR	3.8×10^6	47,000	2,400	3,200	?
Option 1					
PLAR	3.8×10^6	47,000	2,400	3,200	?
AIS	3.6×10^6	5,200	5,150	350	?
Option 2					
Hydrated lime	2.2×10^6	137,000	5,200	16,000	?

July 28, 2006 Dietz-Gourley Consulting, LLC

Table 7. Comparison of Early Estimates of Operation & Maintenance Costs* for Potential Treatment Systems (*Labor costs unknown at time of paper submittal).